Experimental report

26/08/2021

Proposal: 3-01-689 **Council:** 4/2020

Title: Study of 99Zr at the spherical-deformed border via beta-decay of 99Y

Research area: Nuclear and Particle Physics

This proposal is a new proposal

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Samples: 99Zr
99Y

Instrument	Requested days	Allocated days	From	To
PN1	14	10	14/09/2020	24/09/2020

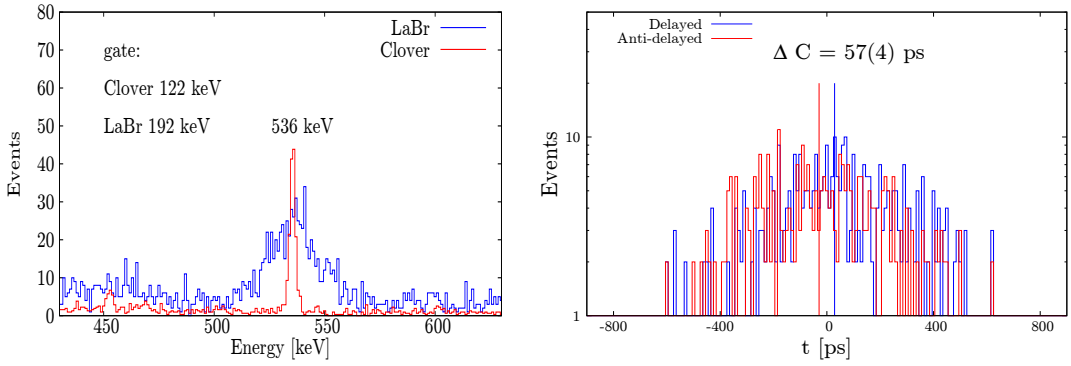
Abstract:

The shape transition in the A$\approx$100 region has been the subject of intense studies lately. The rapid change from the near spherical ^{98}Zr to the strongly deformed ^{100}Zr is well described. The nucleus ^{99}Zr is located exactly at the spherical-deformed border and is therefore an important key parameter to understand the shape change on this region. With the new developments in lifetimes measurements in combination with the Lohengrin spectrometer, new level lifetimes can be measured. With the newly gained information and state of the art microscopic IBFM calculations, the two different structures (spherical and deformed) in ^{99}Zr can be verified.

Experimental Report 3-01-689: Study of ^{99}Zr at the spherical-deformed border via β-decay of ^{99}Y

The experiment for the proposal 3-01-689 with the title 'Study of ^{99}Zr at the spherical-deformed border via β-decay of ^{99}Y' was performed successfully at the Lohengrin setup in September 2020. The Lohengrin spectrometer was equipped with four $LaBr_3$(Ce) and one HPGe Clover detectors. Compared to previous experiments the HPGe detector was mounted right next to the ionization chamber yielding sufficient statistics. The HPGe Clover detector was used to select a γ from a triple γ-γ-γ cascade in order to improve the peak-to-background (p/b) ratio of the $LaBr_3$(Ce). With the $LaBr_3$(Ce) the time difference between the two remaining γ rays of the cascade can be measured. With the help of the calibrated prompt response difference (PRD) lifetimes can be extracted. The PRD has been optimized for the energy region from 40-1500 keV which is exactly the region of the transitions in ^{99}Zr.

As example of the analysis the lifetime measurement of the $(3/2)^+$ state at 658 keV is shown in Figure 1. A Clover gate on the 121 keV→0 keV transition in addition with a LaBr gate on the 850 keV→658 keV transition was applied. The remaining transition, namely the 658 keV→121 keV transition with an energy of 536 keV, can be seen in the left part of Figure 1. The resulting delayed and antidelayed time distributions are shown in the right part in which a centroid difference of $\Delta C = 57$ ps was measured. The statistics in each time distribution is around 300 counts. However we are confident to improve these results by applying further corrections/improvements like wider energy gates or combining different HPGe gates.



(Left) A Clover and a LaBr spectrum showing the 536 keV which has been obtained by gating on the 122 keV (122 keV→ 0 keV) and 192 keV (850 keV→ 685 keV) transitions. (Right) The resulting time distribution after applying a HPGe gate on the 122 keV transition and two LaBr gates to the 536 keV and 193 keV transitions.

In this experiment enough statistics was gathered to remeasure the states at 121 keV, 658 keV and 851 keV with higher precision accomplishing the main goals of the experiment. Furthermore, lifetimes of the 576 keV, 668 keV, 725 keV states can be measured which are important to understand the structure of the states. The analysis of the states at 782 keV, 852 keV, 1051 kev and 1433 keV is ongoing. The lifetimes of the states might yield additional information about the shape coexistence phenomenon. These can be discussed in the context of the interacting boson-fermion model that is based on the microscopic energy density functional [1,2]. This will allows to determine the exact border where the deformed configuration of this nucleus is energetically more favorable. A similar study was performed in Ref. [3]. Furthermore, the reduced transition probabilities can help to suggest or verify different spins and parities. We performed a similar experiment to the $N = 59$ isotone ^{97}Sr where spins have been assigned [3].

References

[1] K. Nomura et al., Phys. Rev. C 93, 054305 (2016)
[2] K. Nomura et al., Phys. Rev. C 96, 014314 (2017)
[3] A. Esmaylzadeh et al., Phys. Rev. C 100, 064309 (2019)